

Modeling and Mapping of Tsunami Inundation in Hawaii

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The sub-tropical insular environment of Hawaii presents a number of challenges in mapping of tsunami inundation. Fringing reefs are present along 70% of Hawaii's coastlines and together with the volcanic insular slopes and shelves produce unique bathymetric and topographic features that have profound effects on near-shore transformation of tsunami waves. We have compiled a digital elevation model consisting of multi-beam data at 50-m resolution along the Hawaiian Island chain, LiDAR data from 40 m water depth to 15 m elevation at 1~3 m resolution for the four counties, and hydrographic survey data for harbors, marinas, and waterways. The digital elevation model has been verified, and rectified as needed, with orthoimages, topographic maps, and hydrographic charts for input to our tsunami model NEOWAVE. In addition to the NTHMP model benchmarks, we have validated NEOWAVE with large-scale reef experiments conducted at Oregon State University and with water-level, current, and runup records of the 2011 Tohoku tsunami in Japan and Hawaii.

We have completed the first phase of inundation mapping based on the five most destructive tsunamis affected Hawaii during the last century. These are the 1946 Aleutian, 1952 Kamchatka, 1957 Aleutian, 1960 Chile, and the 1964 Alaska tsunamis, from which the runup records have been the basis for Hawaii's evacuation maps since their first publication in 1991. Except for the 1946 event, the earthquakes have magnitude 9.2 or higher and return periods of 500 years in their respective subduction zones. The state and the four counties adopt the same criteria in the current effort to update the evacuation maps with the latest digital elevation and tsunami models. The model results are validated by runup records of the five historical tsunamis and evaluated against hypothetical events from local and distant sources. The inundation maps and data products cover 1000 km of the 1500 km of Hawaii coastlines at 9 m resolution. The remaining 500 km of coastlines, which are uninhabited or uninhabitable, are mapped at 90 m resolution.

The second phase of the mapping effort will consider a tsunami generated by a magnitude 9.2+ earthquake near the location of the 1946 Aleutian event. The earthquake will have a return period of 500~1000 years. The corresponding tsunami will have much greater impacts to Hawaii in comparison to the historical events because of proximity and directionality of the source. We have compiled additional LiDAR, space shuttle, and satellite data above 15 m elevation for integration into the digital elevation model. The effort will provide a second set of inundation maps for emergency planning and potentially for development of two-zone evacuation maps for the four counties of Hawaii.